

CLAIMS

1. An apparatus for inspecting food items, the apparatus comprising:

- 5 - conveying means for conveying food items in a predetermined direction;
- means for generating uniform X-ray attenuation image of said food items,
 further comprising:
- 10 - means for forming the food items into a shape of substantially
 uniform thickness;
- X-ray emitting means, for emitting X-rays through said food items
 as they are conveyed by said conveyor through said means for
15 forming the food items;
- X-ray sensing means, for collecting X-rays after penetrating
 through said food items as they are conveyed by said conveyor
 through said means for forming the food items;
- 20 - processing means,

wherein said processing means is adapted to store and/or process X-ray image
data.

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2. The apparatus according to claim 1, wherein the means for generating an uniform
X-Ray attenuation image is adapted to:

- 30 - form at least a linear segment of said food items into a shape of uniform
 thickness,
- and wherein the X-ray sensing means comprises means for detecting at
 least a linear segment of X-rays penetrating through said food items,

35 wherein said linear segment of said food items is formed into a shape of uniform
 thickness.

3. The apparatus according to claims 1 or 2, wherein the X-ray sensing means are
selected from the group consisting of a film sheet, a linear sensor, an image
40 intensifier and a flat panel sensor.

4. The apparatus according to any of the preceding claims, wherein the means for
forming the food items are adapted to allow X-rays to pass through the means for
forming the food items into a shape of substantially uniform thickness as well as
45 the formed food items.

5. The apparatus according to any of the preceding claims, wherein the means for
forming the food items comprises:

- a first roller,

wherein the first roller is able to rotate freely, or is alternatively, driven by a motor which speed is synchronized with the speed of the conveying means.

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6. The apparatus according to claim 5, wherein the first roller is positioned substantially perpendicular to the conveying direction.

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7. The apparatus according to any of the claims 5-6, wherein the means for forming the food items further comprises:

- an endless belt which is positioned in between the first roller and the conveying means,

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wherein the belt is stretched at a fixed angle with respect to the conveying means.

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8. The apparatus according to claim 7, wherein the angle between the conveying means and the belt is in the range of about 0°-90°, such as about 5°-80°, such as about 10°-50°, including about 10°-40°.

9. The apparatus according to any of the claims 5-8, wherein the means for forming the food items further comprises:

- a second roller,

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wherein the first roller and the second roller are oriented in a parallel fashion on either side of said X-ray sensor, and wherein said endless belt presses onto the food items as they are conveyed through the X-ray beam.

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10. The apparatus according to any of the claims 5-9, wherein the first and/or second roller is mounted at a fixed distance from the conveying means, such that a substantially uniform thickness of formed food items in between the roller and the conveying means is obtained as the items pass through said means for generating uniform X-ray attenuation image of said food items.

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11. The apparatus according to any of the claims 5-10, wherein said first roller and/or said second roller is mounted on a mechanism for allowing variations in the distance between the conveying means and the roller as the food items passes under the roller.

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12. The apparatus according to claim 11, wherein the first and/or second roller is mounted on a spring mechanism.

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13. The apparatus according any of the claims 5-12, wherein said first roller and/or said second roller is comprised of a hollow cylinder.

14. The apparatus according to any of the claims 1-4, wherein the means for forming the food items are comprised of a stationary guide.

15. The apparatus according to claim 14, wherein said stationary guide comprises an elongated member with an overall convex shape in the conveying direction, as seen from the conveying means.
- 5 16. The apparatus according to claims 14 or 15, wherein said stationary guide is mounted on a mechanism for allowing variations in the distance between the conveying means and the roller as the food items passes under the roller.
- 10 17. The apparatus according to any of the claims 14-16, wherein said stationary guide is mounted on a spring mechanism.
- 15 18. The apparatus according to any of the claims 5-17, wherein said means for forming the food items are comprised of a material such as a plastic material, that allows essentially full permeation of radiation from the X-ray emitter.
19. The apparatus according to any of the claims 5-17, wherein said means for forming the food items are comprised of a material that modifies the emitted spectrum of X-rays in a predetermined manner, thus serving as an X-ray filter.
- 20 20. The apparatus according to any of the claims 14-17, wherein said stationary guide comprises a perforation along its longitudinal axis, during which emitted X-rays pass.
- 25 21. The apparatus according any of the preceding claims, further comprising a controller for adjusting the amount of pressure exerted by said means for forming the food items.
- 30 22. The apparatus according to claim 21, wherein said adjustment is based on analysis of the surface height of the food items prior to X-ray imaging.
- 35 23. The apparatus according to claims 21 or 22, further comprising a force sensor for sensing the force of the applied pressure, said force sensor being functionally linked to the controller for adjusting the amount of pressure exerted by said means for forming said food items.
- 40 24. The apparatus according to any of the claims 21-23, wherein the amount of pressure is adjusted in real-time, based on the degree of compression determined from X-ray data collected from the compressed food items as they pass through the X-ray beam.
- 45 25. The apparatus according to any of the preceding claims, further comprising means for registering the nature, location and quantity of observed bones, bone fragments or other undesired materials in said food items.
26. The apparatus according to any of the preceding claims, further comprising:
- means for registering which food items, or which part of the food stream, contain bones, bone fragments or other undesired materials, and

- means for using this information to make decision on further action on the food material,

wherein such decision may involve routing or removing said food items accordingly.

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27. The apparatus according to any of the preceding claims, wherein the conveying means are comprised of a conveyor wherein a recess or a gap in the conveyor support is provided, such that the distance between the conveying surface and the means for forming the food items can be varied by varying the depth, length and/or width of the recess, and the tension of said endless belt.

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28. A method for inspecting food items for the presence of bones, bone fragments or other undesired material, the method comprising the steps of:

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- conveying food items along conveying means in a predetermined direction;
- means for generating uniform X-ray attenuation image of said food items by forming said food items into a shape of uniform thickness;
- emitting X-rays through said food items as they are conveyed by said conveyor through said means for forming the food items;
- generating X-ray image from collecting attenuated X-rays after penetrating through at least one segment of said food items as they are conveyed by said conveyor through said means for forming said food items;
- image processing and analyzing of the generated X-ray image,

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wherein said image processing and analysis of the X-ray image data determines if any of said segments of food items contains bones, bone fragments or other undesired material.

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29. The method according to claim 28, wherein the food items are de-boned food items.

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30. The method according to any of the claims 28-29, further comprising removing food items determined to contain bones, bone fragments or undesirable material from the conveying means into a receiving means by means of a displacement mechanism.

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31. The method according to claim 30, wherein the receiving is selected from the group consisting of a receiving bin, a conveyor and a processing line.

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32. The method according to any of the claims 28-31, further comprising sending an alarm signal when bones, bone fragments or other undesired materials are detected.

33. Use of an X-ray apparatus in the detection of bones, bone fragments or other undesired materials in food items, said use comprising:

- 5 - obtaining an X-ray image of at least one segment of the food items while conveyed on a conveying means,

10 wherein at least a segment of said food items are simultaneously formed into a shape of uniform thickness, such that a X-ray image data of at least a segment of food items of substantially uniform thickness is obtained, and wherein image analysis of the acquired X-ray image data is used to determine if bones, bone fragments or other undesired material are present in the food items.

15 34. The use according to claim 33, further comprising sending an alarm signal when image analysis of X-ray images identifies bones, bone fragments or other undesired material in the food items.